A NOTE ON THE EFFECT OF THE PHOTO-ELECTRIC EMISSION FROM THE ELECTRODES ON THE RECTIFYING ACTION OF A DISCHARGE

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ABSTRTCT. The effect of the photoelectric emission from one of the electrodes on the rectifying effect of a discharge has been quantitatively investigated by using an improved dynamic method. The rectification is found to be affected to some extent by the onset of the emission, but the effect is found to be non-selective, it increases the current during one half of the cycle, leaving the current in the other half unaffected.

The effect of some of the parameters of the discharge, like the nature of the gas in the discharge tube, its pressure, the relative areas of the electrodes etc., on the rectifying action of a discharge have been reported in some detail by the author (Chiplonkar 1939, 1941). The method used was to connect a D.C. and an A.C., milliammeter in the earth circuit, the former indicating the D.C. component and the latter the total current. It is the object of the present paper to report some observations, with an improved and more accurate method on the possible role of an important process in the discharge tube, *viz.*, the photo-electric emission from the electrodes, in determining its rectifying action. The existence of an assymmetric process occurring at only one of the electrodes leads, as we know, to rectification in the plate and point rectifier. It was thought, therefore, worthwhile to investigate if the presence of the photo-electric emission from one of the electrodes would result in a selective action on the part of the discharge, the discharge passing with greater ease in one direction than in the other.

The observations were made with a gas-filled photo-cell (R.C.A. 868) The conditions obtaining in this type of cell would not be far different from those in ordinary discharge tubes. One electrode consists of a concave metal plate, the other is a thin wire placed in front of it. A variable A.C. voltage (0-90 volts) was applied across the cell; the anode being connected to the A.C. source, as shown in Fig. 1. The earth current

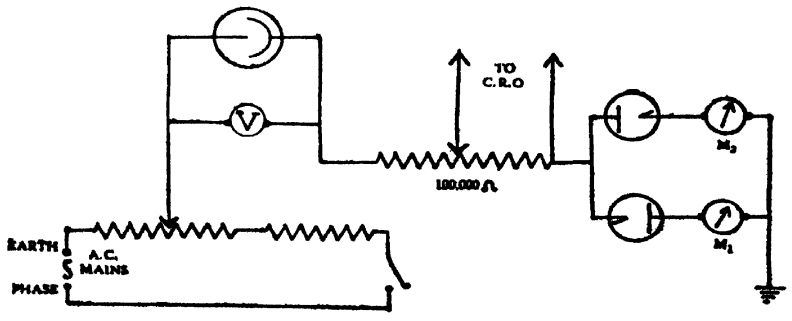

FIG. 1

through the cathode was analysed with the help of two diodes and two galvanometers (microammeters). The current pattern was also observed on a cathode ray oscillograph, by putting the potential drop across part of the high resistance, placed in series with the cell, on the vertical plates of the C.R.O. When the rectification is absent the currents indicated by M_1 and M_2 are equal and the pattern on the C.R.O. is symmetrical. The presence of rectification is shown by unequal readings in M_1 and M_2 and by an assymmetry in the C.R.O. pattern. The method is sensitive and enables one to evaluate the impendance of the tube in the two directions and thus helps to determine dynamically in an accurate manner the rectification produced.

The observations taken are shown in Table I. Readings have been taken when the cell is in the dark and next when exposed to light from a lamp kept at a fixed distance from it. On incidence of light the P.D. across the cell falls; for the sake of comparison the readings obtained in dark and in light are shown side by side. The rectification ratio ρ now gives the value of $\frac{M_2-M_1}{M_2+M_1}$. Complete rectification is obtained for $\rho=1$.

TABLE I

In dark				Under light			
P. D. across cell, volts	M_1 divs	M_2 divs	ρ	P D. volts	M_1 divs	M_2 divs	ρ
2.0	0.00	1.50	1.00	1.0	0.00	1.50	1.00
4.0	0.25	1.75	0.75	3.0	0.25	2.00	0.77
6.0	0.50	2 00	0.60	5.0	0.50	2.50	0.66
10.0	0.50	3.00	0 71	9.0	0.50	3.25	0.73
20.0	1.00	4.50	0.63	17 0	1.00	5.50	0.69
30.0	1.75	6.50	0.57	27.0	1.75	7.50	0.61
40.0	2.75	8.60	0 51	35.0	2.75	9.50	0.55
50.0	4.25	10.00	0.40	46.0	4.25	11.50	0.45
60.0	5.50	11.75	0.36	53.0	5 75	13.50	0.40
70.0	7.00	13.50	0.31	61.0	7.00	15.00	0.36
80.0	9.00	15.00	0.25	69.0	9.00	16.50	0 29
90.0	11.00	16.50	0.20	79.0	11.00	18.00	0.24

The effect of the photo-electric emission seems to be merely to increase the current during the half of the cycle when the potential on the cathode is negative, the current in the positive half of the cycle remains unaffected. In the observations given above, the rectification, which is

initially present, increases in value when the photo-electric emission takes place. For the voltages used, the cell does not function as a rectifier except at very low voltages of the order of 0.5 volts. This result has been found to be characteristic not only of the photo-cell used above, but is shown by a photronic cell, and an ordinary discharge tube when they are used in place of the cell. The magnitude of the rectification is found to diminish with increasing voltage. There does not appear to be present a selective action of a marked magnitude. The observations with the C.R.O confirm the general results discussed above. There is assymmetry not only in the positions of the peaks but also in the wave-form in the two half cycles; the curve during the positive cycle shows a sharper maximum than that obtained during the negative half of the cycle. The double diode arrangement is found to be more sensitive than the C.R.O. as far as the quantitative results are concerned. Incidentally, these results indicate that the measurement of an A.C. current, in circuits where partial rectification effects are obtained by means of a rectifier or any other similar type of instrument may not give sufficiently detailed information about the current.

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References

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